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Abstract

REVIEW OF PROGRESS OF DEVELOPMENT, MANUFACTURE, AND PERFORMANCE OF MAGNOX FUEL ELEMENTS IN THE UNITED KINGDOM

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ABSTRACT

INTRODUCTION

1. The progress of the provision of Magnox fuel elements for the United Kingdom Nuclear Power Programme is reviewed in respect of development, manufacture and performance for the interval since the last Geneva Conference. Attention is concentrated on items which can be regarded as of key importance and these are necessarily treated briefly:

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PRESENT POSITION

2. Various aspects of the accelerating build-up of Nuclear Power production in the United Kingdom towards the target of 5,000 MW(E) by 1969 are referred to: the build-up of fuel element production at the Springfields Works of the U.K.A.E.A. in line with requirements (the Sizewell initial fuel charge is currently being manufactured); the very satisfactory behaviour of the Bradwell and Berkeley stations of the Central Electricity Generating Board; and the successful commissioning of Hunterston.

3. Reference is also made to the successful commissioning of the Latina station of the Societa Italiana Meridionale Energia Atomica and to the completion of manufacture of the first charge of fuel for the Tokai Mura station of the Japan Atomic Power Company.

4. Examples of the irradiation levels reached by the various designs of Magnox fuel elements are given.

IMPORTANT DEVELOPMENTS IN THE PERIOD 1959 - 1964

5. Reference is made to the policy adopted of parallel development of alternative solutions for certain key items. Such key items were the canning alloy, the high strength structural alloy for the end fittings of stack-loaded elements, and finally, the uranium fuel rod.

6. The alternatives developed in the instances cited above are referred to and the results obtained both out of pile and from irradiation experiments and large-scale irradiation trials are outlined. Manufacturing processes associated with the alternative solutions are discussed briefly and reference is made where relevant to the impact of the alternative solutions on reactor operations and on the subsequent processing of irradiated fuel.

7. The problems arising from grain boundary cavitation of the canning alloys, the solution adopted, and the manufacturing implications; and the plutonium diffusion problem with the ZR55 canning alloy are referred to. The occasional occurrence of rapid failures during reactor service, the generally accepted explanation of these rapid failures, the development work carried out and in progress, and the impact on manufacturing and reactor operation procedures are also referred to.

8. The highlights of the changes in dimensions in physical properties and in microstructure occurring as a consequence of irradiation of the fuel rods and

canning materials and the results of in-pile thermal cycling experiments on the cans are discussed.

FUTURE TRENDS

9. The view is expressed that the development of Magnox fuel elements has now reached the end of a phase of progressive improvement of the solid cylindrical rod polyzonal heat transfer surface element; further improvements, mainly of a manufacturing nature, will continue, but there is diminishing return for design changes. It is suggested that any fresh advances will have to be achieved with herringbone heat transfer surfaces and tubular or plate-type fuel. A robust but simple herringbone element is visualised. This represents a reversal of the earlier trend, when development work revealed the need for reinforcement and stabilisation of the earliest conceptual designs with the consequential trend to more component parts and greater complication. The robust streamlined designs visualised are expected to ultimately combine the advantages of reduced manufacturing cost with increased endurance in reactor service.